Forest Health Protection
Pacific Southwest Region

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To: Mary Martin, Park Superintendent, Lassen Volcanic National Park

Subject: Evaluation of Insect and Disease Activity in the Juniper Lake Campground, Lassen Volcanic National Park (NE06-16)

At the request of Jon Arnold, Forester, Lassen Volcanic National Park, Danny Cluck, Forest Health Protection (FHP) Entomologist, and Bill Woodruff, FHP Plant Pathologist, conducted a field evaluation of the Juniper Lake campgrounds on September 7, 2006. The objective of the visit was to evaluate the current forest health conditions within and adjacent to campsites and to provide management recommendations as appropriate. These recommendations will assist with planning future activities, including campground renovations and vegetation and hazard tree management within the recreation area. Jon Arnold accompanied us in the field.

Background

Juniper Lake is located within the southeast corner of Lassen Volcanic National Park (T30N, R6E, Section 22) at an elevation of 6800 feet. Precipitation for the site averages 60 - 80 inches per year. The campgrounds are located on the east edge of the lake in a predominately lodgepole pine (*Pinus contorta var. murrayana*) and red fir (*Abies magnifica*) forest. Western white pine (*Pinus monticola*), white fir (*Abies concolor*) and Jeffrey pine (*Pinus jeffreyi*) can be found in adjacent stands upslope from the campground area. All stands contain an old growth, large tree component (mostly red fir, western white and Jeffrey pine) and dense pockets of small diameter trees (mostly true fir and lodgepole pine). The management objectives for this recreation area are to promote and maintain the presence of healthy trees, reduce the occurrence and spread of root disease and reduce the number of hazard trees.

NORTHEASTERN CALIFORNIA SHARED SERVICE AREA
2550 RIVERSIDE DRIVE
SUSANVILLE, CA 96130
530-257-2151

Danny Cluck
Entomologist
dcluck@fs.fed.us

Bill Woodruff
Plant Pathologist
wwoodruff@fs.fed.us

Observations

Lodgepole pine dwarf mistletoe (*Arceuthobium americanum*) has infected a few lodgepole pine within the campground causing bole and limb swelling and branch brooming. Western gall rust (*Peridermium harknessii*) was found infecting a couple of lodgepole pine resulting in bole cankers.

One or more species of brown rot fungi were observed in both red fir and lodgepole pine causing extensive heartwood decay, especially in older trees. Many of these infected trees, and recently cut stumps of infected trees, have fire scars at the base, approximately 100 years old, that may have served as entry courts for the decay fungi.

Older mountain pine beetle strip attacks were observed on living lodgepole pine located near the lake shore. Many of these trees had partially exposed root systems due to soil erosion caused by wave action. The older strip attacked areas have subsequently been attacked by wood boring beetles (families: Buprestidae and Cerambycidae) and infected by decay fungi.

Large diameter red fir appear to have several biotic agents working against them such as annosus root disease (*Heterobasidion annosum*), brown heartwood decay (species unknown) and wood boring beetles. A few of these trees died within the past several years and were subsequently removed. The remaining large diameter red fir are generally showing crown decline and/or are being attack by wood boring beetles. Despite the level of heartwood decay and the presence of annosus root disease there is very little evidence of significant blow down in the area. A few of the smaller red fir trees have a light level of dwarf mistletoe and cytospora canker infection but are growing well.

Both lodgepole and red fir in several campsites have been injured by campers throwing hatchets at tree boles. Some of these trees have been severely damaged. There is also some compaction occurring within the campsites but does not appear to be negatively affecting tree health.

Discussion

Trees in the Juniper Lake campground, similar to most forested campgrounds, are exposed to additional stress factors that can compromise their health and vigor. Firewood collecting sometimes leads to tree wounding from hatchets and saws, tree bole carving and chopping causes extensive damage to bark and sapwood, foot and vehicle traffic from campers can result in increased soil compaction and root damage, and the desire for screening between campsites can result in overstocking of understory trees.

Root decay caused primarily by *H. annosum* in red fir and heartwood decay in both red fir and lodgepole pine are the most serious conditions identified in the Juniper Lake area. Many trees have been felled over the years that had previously succumbed to some combination of root disease, heartwood decay, and wood boring and bark beetle attacks. Some of these trees were likely hazardous before they died. With this many trees affected in a campground, it is critical that the remaining live trees are evaluated and potential hazards identified. Treatment for a hazard tree (a defective tree located where it could kill or injure people or damage property if it fell) is to remove the tree or to keep people away from the tree. The most effective ways to keep people away from hazard trees are to move the facility (picnic table,

campsite, toilet, etc) or construct barriers around the trees.

Identifying hazards by signing generally does not relieve an agency from liability for injury or damage caused by known tree hazards. Liability can only be eliminated by closing hazardous areas or removing the hazard. Liability can be minimized by implementing an on-going tree hazard identification and treatment program for recreation areas. This program would involve periodically examining trees in recreation areas, removing or mitigating those deemed hazards and monitoring questionable trees over time. This type of a program is currently in practice at Lassen Volcanic National Park.

For trees with branch swelling and brooms caused by dwarf mistletoe, depending on the degree of symptoms, consideration should be given to tree removal or at a minimum selective pruning within the crown to remove the dead or diseased limbs that could snap off and strike campers. Removing infected limbs will also reduce the number of seeds that can disperse and infect susceptible understory trees. Depending on the level of dwarf mistletoe infection, removal of infected limbs can improve the health and vigor of the tree as long as at least 50% of the original live crown remains after treatment.

Tree wounding by careless campers is a significant issue at Juniper Lake. To help prevent human caused tree injuries, which have the potential of creating hazard trees or even causing tree mortality, a public awareness poster should be placed at the campground entrance to inform campers about the importance of trees to the area and the problems associated with tree wounding from hatchets, axes, knives and nails.

Stands within the Juniper Lake campground area would benefit by the removal of diseased trees and a reduction in stand density. When thinning trees where annosus root disease is present, it is beneficial to create a mix of tree species and sizes while limiting the number of true fir. In addition, when selecting trees for removal, preference should be given to trees infected with dwarf mistletoe, root disease and trees infested with bark beetles. For root diseases, it is reasonable to use the condition of the crown as an indicator of advanced decay. Although not always caused by root decay, a thin crown does indicate poor tree vigor. A tree with reduced photosynthesis is not able to maintain healthy roots as well as a tree with a full and healthy crown. In the presence of root disease, unhealthy roots will likely be overcome with decay faster than vigorously growing roots. For this reason, the thinner the crown of a tree in an area where root disease is present, the more likely it is that the roots have been weakened by decay.

Lodgepole pine appears to be overstocked in several pockets in and around the campground and even appears to be succeeding red fir in some areas. These pockets would benefit from a reduction in stand density through thinning. Removing individual trees that are heavily infected with dwarf mistletoe or that show signs of bole decay should be the top priority for any green tree or hazard tree removal operation. In general, pure lodgepole pine stands should be thinned to 80 to 100 BA to reduce their susceptibility to bark beetle attacks. However, reducing the basal area in extremely dense stands in one entry can result in wind throw and/or snow breakage of residual trees, therefore, desired stocking levels in pure lodgepole pine stands may be best achieved through multiple entries over time. Mixed stands of lodgepole and red fir may be able to sustain higher stocking levels. In either case, site productivity should be determined and trees thinned to stocking levels appropriate for management objectives. To reduce the susceptibility to future bark beetle related mortality,

stands should be thinned to densities that are 80% or less of "normal", effectively reducing tree competition for limited water and nutrients.

Dense stands adjacent to campgrounds would also benefit from thinning. In addition to reducing tree stress, thinning, especially of the understory, will somewhat reduce the risks and damage from any fire that might occur and provide a more defensible space for the campground. When planning such thinning, it should be recognized that this is an average to be applied across the landscape and some variability may be desired. Individual high value trees, such as mature pine, should benefit by having the stocking around them reduced to lower levels.

Western white pine should be retained as much as possible during any thinning operation in order to preserve genetic diversity, especially white pine blister rust (*Cronartium ribicola*) resistant individuals. White pine blister rust, a non-native pathogen, has continued to weaken and kill this species over most of its range since its introduction into the Pacific Northwest in 1910. Identification and protection of local rust resistant trees for seed collection, if not already occurring, will aid in the future planting of rust resistant seedlings. Planting selected openings created through thinning operations with rust resistant stock would help insure this species persists in the area.

It is important to note that when implementing tree removal or hand thinning in a recreation area, it is important to treat conifer stumps with a registered borate compound to reduce the probability of infection by *Heterobasidion annosum*, the causal agent of annosus root disease. Treating all stumps would provide the best protection against the creation of new root disease centers but time and funding will likely dictate what level of treatment actually occurs. At a minimum, all stumps greater than 8"dbh should be treated. Care also needs to be taken to minimize both wounding of residuals and site disturbance. If regenerating any openings created during thinning and hazard tree removal is desired, planting pine species should be considered over natural regeneration of true fir since pines are not hosts for the fir strain of annosus root disease.

Despite the effectiveness of any long or short-term plans to prevent tree injury and mortality, some trees, through declining health, will eventually become hazards to the public. To minimize the risks associated with hazard trees, they should be identified and removed before they fail. The current practice for many campgrounds is to remove trees as they die. This eliminates the risk from dead trees but fails to address living trees that are infected with root disease, heart rot, and/or have a structural defect. These high-risk green trees are equally hazardous and should not be overlooked. In the short-term, trees within the campground that have obvious stem decay, dead tops and/or large dead branches should be carefully evaluated and hazards removed or pruned as soon as possible. All standing dead trees within striking distance of campsites or campground facilities should be removed immediately. The current Park Service monitoring program is addressing all potentially hazardous trees on an annual basis.

Any future modifications to the Juniper Lake campground should incorporate a long-term vegetation management plan. The recommendations provided in this evaluation combined with specific vegetation management input from LVNP will help insure the continued presence of healthy trees.

If you have any questions regarding this report and/or need additional information please contact Danny Cluck at 530-252-6431 or Bill Woodruff at 530-252-6680.

/s/ Danny Cluck

Daniel R. Cluck
Entomologist
NE CA Shared Services Area

/s/ Bill Woodruff

William Woodruff
Plant Pathologist
NE CA Shared Services Area

cc: Jon Arnold, LVNP
Forest Health Protection, Regional Office

General Recommendations for Campground Construction and Vegetation Management

Maintaining and promoting healthy trees are important objectives for development plans in campgrounds. Care should be taken during future campsite, trail and facility construction to minimize negative impacts on the landscape. The following guidelines should be applied for areas under construction or in areas where future construction will take place.

- Tree density should be appropriate for the site. This will provide access to light, moisture and nutrients and allow the trees to better cope with their altered environment.
- Trees that will directly interfere with structures or that will be seriously damaged during construction or excavation should be removed.
- Leave a mixture of ages and species to provide a continual forest canopy over the years.
- Fence off individual or groups of trees before construction to negate or minimize root damage by soil compaction or trunk and root damage by equipment. Protective fences should be placed, at a minimum, at drip line. Depending on the species, tree roots can exist within a radius two times the crown radius and encompass an area well beyond drip line. Drip line is defined by the outer edge of the foliage. Penalties for damaging trees should be incorporated into tree removal or construction contracts.
- Road or lot grades should be changed as little as possible. Grading damages roots and can set up conditions that favor soil erosion. It can also alter the contour such that the flow of surface and subsurface water is drastically affected.
- Trenches should always be dug away from tree roots.
- Do not back fill with earth or rocks around the trunks of trees.
- Avoid paving with either concrete or asphalt over root systems, or close to the trunks of trees.
- Use caution in applying wood preservatives and other chemicals to buildings. Trees and other plants have been killed by direct contact with them or as a result of their runoff in rainwater.
- Avoid leaving green pine slash on site to prevent the build up of pine engraver (*Ips pini*) beetle populations that may attack standing green trees.

Future construction or vegetation management activities that incorporate the above guidelines will help assure the existence of vigorous and healthy trees following project completion.

Insect and Disease Information

Annosus Root Disease

Heterobasidion annosum is a fungus that attacks a wide variety of woody plants. All western conifer species are susceptible. Madrone (*Arbutus menziesii*), and a few brush species (*Arctostaphylos spp.* and *Artemisia tridentata*) are occasional hosts. Other hardwood species are apparently not infected. The disease has been reported on all National Forests in California, with incidence particularly high on true fir in northern California, in the eastside pine type forests, and in southern California recreation areas.

Annosus root disease is one of the most important conifer diseases in Region 5. Current estimates are that the disease infests about 2 million acres of commercial forestland in California, resulting in an annual volume loss of 19 million cubic feet. Other potential impacts of the disease include: increased susceptibility of infected trees to attack by bark beetles, mortality of infected trees presently on the site, the loss of the site for future production, and depletion of vegetative cover and increased probability of tree failure and hazard in recreation areas.

During periods favorable to the fungus, fruiting bodies (conks) form in decayed stumps, under the bark of dead trees, or under the duff at the root collar. New infection centers are initiated when airborne spores produced by the conks land and grow on freshly cut stump surfaces. Infection in true fir may also occur through fire and mechanical wounds, or occasionally, through roots of stumps in the absence of surface colonization. From the infected stump surface, the fungus grows down into the roots and then spreads via root-to-root contact to adjacent live trees, resulting in the formation of large disease centers. These infection centers may continue to enlarge until they reach barriers, such as openings in the stand or groups of resistant plants. In pines, the fungus grows through root cambial tissue to the root crown where it girdles and kills the tree. In true fir and other non-resinous species, the fungus sometimes kills trees, but more frequently is confined to the heartwood and inner sapwood of the larger roots. It then eventually extends into the heartwood of the lower trunk and causes chronic decay and growth loss.

Heterobasidion annosum in western North America consists of two intersterility groups, or biological species, the 'S' group and the 'P' group. These two biological species of *H. annosum* have major differences in host specificity. All isolates of *H. annosum* from naturally infected ponderosa pine, Jeffrey pine, sugar pine, Coulter pine, incense cedar, western juniper, pinyon, and manzanita have, to date, been of the 'P' group. Isolates from true fir and giant sequoia have been of the "S" group. This host specificity is not apparent in isolates from stumps; with the 'S' group being recovered from both pine and true fir stumps. These data suggest that infection of host trees is specific, but saprophytic colonization of stumps is not. The fungus may survive in infected roots or stumps for many years. Young conifers established near these stumps often die shortly after their roots contact infected roots in the soil.

Western Gall Rust

Western gall rust (Peridermium harknessii) causes branch galls and trunk cankers on nearly all species of hard pines. The rust fungus produces yellow to orange-colored spores (aeciospores) on the surface of the galls during cool, moist, spring weather the second or third year after infection. New crops of spores are produced yearly thereafter until the host tissue dies. Dispersal of spores by wind occurs usually in May and June. After spores land on susceptible tissues, especially after rainfall, some germinate and cause new infections. Most infections occur on current-year shoots. There is considerable yearly variation in the amount of infection in the West, where abundant infection in given stands occurs in relatively few years.

The fungus infects pines of all sizes and ages. Seedlings are the most susceptible and are often killed within a few years by girdling stem galls. In nurseries, galls may develop on seedlings as a result of infection by spores from surrounding infected stands and windbreak trees. Branch infections on mature trees usually are of slight importance; however, branch infections of highly susceptible trees may exceed 100 galls and consequently would reduce growth potential. Stem infections can result in growth loss and cull. Galls resulting in cankers may continue to grow slowly for more than 200 years eventually resulting in stem deformity. Cankers form weak points making stems and branches susceptible to wind breakage. Cankers also create avenues through which decay fungi can enter stems.

Dwarf Mistletoe

Dwarf mistletoes (Arceuthobium spp.) are parasitic, flowering plants that can only survive on living conifers in the Pinaceae. They obtain most of their nutrients and all of their water and minerals from their hosts.

Dwarf mistletoes spread by means of seed. In the fall the fruit ripen and fall from the aerial shoots. The seeds are forcibly discharged. The seed is covered with a sticky substance and adheres to whatever it contacts. When a seed lands in a host tree crown, it usually sticks to a needle or twig, where it remains throughout the winter. The following spring the seed germinates and penetrates the twig at the base of the needle. For the next 2-4 years, the parasite grows within the host tissues, developing a root-like system within the inner bark and outer sapwood, and causing the twig or branch to swell. Aerial shoots then develop and bear seed in another 2-4 years.

Dispersal of dwarf mistletoe seeds is limited to the distance the seeds travel after being discharged. From overstory to understory, this is usually 20 to 60 feet, but wind may carry them as far as 100 feet from the source. A rule of thumb is that the seeds can travel a horizontal distance equal to the height of the highest plant in an infected tree. There is some evidence that long distance spread of dwarf mistletoe is occassionaly vectored by birds and animals.

Vertical spread within tree crowns of most dwarf mistletoes is limited to less than one foot per year because of foliage density. Because of the thin crowns of gray pine, however, the vertical rate of spread has been measured as being greater than 2 feet per year. This rate of spread equalled or exceeded the rate of height growth of infected trees.

Dwarf mistletoes are easy to identify because they are generally exposed to view within a tree's crown. Signs of infection include the yellow-green to orange mistletoe plants, basal cups on a branch or stem where the plants were attached, and detached plants on the ground beneath an infected tree. Symptoms include spindle-shaped branch swellings, witches' brooms in the lower crown, and bole swellings.

Mountain pine beetle

The mountain pine beetle, *Dendroctonus ponderosae,* attacks the bole of ponderosa, lodgepole, sugar and western white pines larger than about 8 inches dbh. Extensive infestations have occurred in mature lodgepole pine forests. Group killing often occurs in mature forests and young overstocked stands of ponderosa, sugar and western white pines.

Evidence of Attack

The first sign of beetle-caused mortality is generally discolored foliage. The mountain pine beetle begins attacking most pine species on the lower 15 feet of the bole. Examination of infested trees usually reveals the presence of pitch tubes. Pitch tubes on successfully infested

trees are pink to dark red masses of resin mixed with boring dust. Creamy, white pitch tubes indicate that the tree was able to "pitch out" the beetle and the attack was not successful. In addition to pitch tubes, successfully infested trees will have dry boring dust in the bark crevices and around the base of the tree. Attacking beetles carry the spores of blue-staining fungi which develop and spread throughout the sapwood interrupting the flow of water to the crown. The fungi also reduces the flow of pitch in the tree, thus aiding the beetles in overcoming the tree. The combined action of both beetles and fungi causes the needles to discolor and the tree to die.

Life Stages and Development

The beetle develops through four stages: egg, larva, pupa and adult. The life cycle of the mountain pine beetle varies considerably over its range. One generation per year is typical, with attacks occurring from late June through August. Two generations per year may develop in low elevation sugar pine. Females making their first attacks release aggregating pheromones. These pheromones attract males and other females until a mass attack overcomes the tree. The adults bore long, vertical, egg galleries and lay eggs in niches along the sides of the gallery. The larvae feed in mines perpendicular to the main gallery and construct small pupal cells at the end of these mines where they pupate and transform into adults.